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**Cultural quotas in broadcasting I: a model\***

**Martin Richardson**

School of Economics  
Faculty of Economics and Commerce  
Australian National University  
Canberra, ACT 0200  
Australia  
[martin.richardson@anu.edu.au](mailto:martin.richardson@anu.edu.au)

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**Abstract**

This paper develops a Hotelling location model in which two radio stations choose combinations of local and international content to play, given consumers with preferences distributed over those combinations. Station revenue derives from sales of advertising time, the demand for which depends negatively on the price and positively on the station's market share and consumers get disutility from advertising and from a less-than-ideal broadcast mix of local and international content. In this setting we show that the laissez-faire solution involves less than (socially optimal) maximal differentiation.

**Keywords:** radio, public broadcasting, Hotelling

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## I. INTRODUCTION

“Local content rules are essential public interest requirements for countries such as Australia and Canada which wish to maintain separate national cultural identities or to nurture national cohesion.”<sup>1</sup> Simply substitute the appropriate country for ‘Canada’ or ‘Australia’ and one could find similar passages for many other countries.<sup>2</sup> Many countries have expressed concerns that local culture is threatened by an international cultural hegemon (i.e. the U.S.), be it in film, television or music played on radio stations. As a consequence, elaborate and long-lasting local content requirements have been implemented all over the world. For example, the first Canadian radio station to broadcast regular programming – XWA/Montreal – went to air in 1919; in 1932 the Canadian Radio Broadcasting Commission (CRBC) was established to regulate and control all broadcasting in Canada and provide a national broadcasting service, determining the number, location and power of radio stations as well as the time that should be devoted to national and local programming.

Numerous rationales have been provided for such schemes – national prestige, merit goods, production externalities – but most usually hinge on another externality argument: that such schemes preserve local culture (by increasing the demand for its outputs) and this generates some intangible spin-off.<sup>3,4</sup>

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<sup>1</sup> Gareth Grainger, Deputy Chairman, Australian Broadcasting Authority, “Broadcasting, co-regulation and the public good”, 1999 Spry Memorial Lecture, 28 October 1999, p.39 (available at [http://www.aba.gov.au/abanews/speeches/bcasing\\_info/pdf/rf/gg\\_spry99.rtf](http://www.aba.gov.au/abanews/speeches/bcasing_info/pdf/rf/gg_spry99.rtf)).

<sup>2</sup> Even the U.S.! Paul Krugman writes, in a nice reversal, “[t]he same goes for cultural choices: Boston residents who indulge their taste for Canadian divas do undermine the prospects of local singer-songwriters and might be collectively better off if local radio stations had some kind of cultural content rule.” (*Slate* 23/11/99 at <http://slate.msn.com/id/56497/>.)

<sup>3</sup> See Jacobsen (2000). Of course, as Jacobsen notes, local content requirements affect supply only and cannot ensure that increased local programming is actually consumed, a feature we see in our model.

<sup>4</sup> Or tangible spin-off – such schemes are generally viewed favourably by domestic artists as they are seen to increase payments to such artists by increasing the demand for their outputs. We do not consider this explicitly; effectively, we suppose there is free entry into music production so artists earn competitive returns. Nevertheless, any supernormal returns are easily handled in our framework as a part of the externality that accrues from an increased audience for local content.

One might anticipate a number of consequences of a cultural quota. Presumably it is perceived that, in its absence, consumers listen to ‘too much’ international content and not enough local content.<sup>5</sup> A quota, then, might simply induce entry by local artists, as demand for their output increases and, to the extent that their entry was unprofitable before the quota, this must represent a welfare loss from reduced quality.<sup>6</sup> Alternatively, programming might simply concentrate on domestic artists that are very similar in style and quality to those already programmed<sup>7</sup> (although some schemes do not count such artists as local: see fn. 5.)

In this paper we take rather a different approach to modelling radio broadcasting. Instead of focusing on the *production* of local content – the artists – our concentration is on the medium of its dissemination. So we do not consider the performing arts sector but rather focus on the impact of a cultural quota on radio stations and how much local content they play (and how much is *heard*). Taking the proponents of cultural quotas at face value, we suppose that there *is* something about local content that is different from the international product that is not a quality difference. We suppose that there is horizontal rather than vertical differentiation between local and international content and take this as given.<sup>8</sup> Furthermore, we

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<sup>5</sup> Defined in whatever way. The Canadian MAPL system generally requires that Canadian content satisfy two of the following requirements: M (music) – the music is composed entirely by a Canadian; A (artist) – the music is, or the lyrics are, performed principally by a Canadian; P (production) – the musical selection consists of a live performance that is (i) recorded wholly in Canada, or (ii) performed wholly in Canada and broadcast live in Canada; L (lyrics) – the lyrics are written entirely by a Canadian. By this reasoning, much of the music of Krugman’s “Canadian divas” (cf. fn. 2) does not qualify as Canadian content. See [http://www.crtc.gc.ca/eng/INFO\\_SHT/R1.htm](http://www.crtc.gc.ca/eng/INFO_SHT/R1.htm). See also Krattenmaker and Powe (1994) for a comprehensive discussion of the philosophy and practice of the regulation of broadcasting.

<sup>6</sup> Although it has been suggested that these might need only be temporary schemes – consumers are simply unaware of the quality of local music, film or television and, once exposed to it through a local content requirement, will voluntarily continue to consume it in the scheme’s absence. On this, note that Canada has had local content requirements for over 40 years.

<sup>7</sup> This, of course, is exactly the *opposite* of the quota’s desired effect, encouraging domestic artists to become more like international ones rather than preserving any perceived cultural distinctiveness.

<sup>8</sup> Technically, in fact, we have aspects of both horizontal and vertical differentiation in this model.

allow that the hearing of local content might yield some external benefit to policymakers, perhaps reflecting the cultural arguments that the proponents of quotas claim. Preferences for the mix of the two types of content vary across consumers, however, and radio stations choose their mix of content types to play in an effort to maximise advertising revenue. Consumers dislike advertising (although it is socially desirable, as we discuss later) but advertisers attempt to reach the largest audience possible. A cultural quota, then, is effectively a locational constraint on radio stations.

Note that, while it appears that the competition between stations here is between characteristics of the stations themselves, rather than the programming they offer, in fact the locational choice *is* effectively a programming decision. Our assumption that local and international content are different in kind can be interpreted as either being independent of programming genre (that is, as applying to similar-format stations) or as applying across genres. That is, if local content correlates with genres (being more concentrated in rock music than classical, say) then a cultural quota can be interpreted as a constraint on the genre formats of radio stations.<sup>9</sup>

The present paper focuses on developing the model – a companion piece<sup>10</sup> analyses the effects of some alternative policies. We show here that we get less than maximal differentiation between the stations in the absence of any quota. The social optimum, *sans* externality, is maximal differentiation and this is also the outcome that would be chosen by the stations were they to collude on their locational choices.

Our analysis is most closely related to Gabszewicz, Laussel and Sonnac (1999; GLS henceforth). They model television broadcasting in much the same way as in

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<sup>9</sup> Indeed, some jurisdictions, such as Australia, have different content requirements across different formats to reflect this.

<sup>10</sup> Richardson (2004).

this paper. But they model advertising very differently which leads to quite different results (such as maximal differentiation in the laissez faire solution) and their only policy concern is with the impact of advertising limits. Another closely-related paper is that of Gal-Or and Dukes (2002) who also consider a spatial model of broadcasting location with broadcasters funded by informative – but nuisance – advertising, as in this paper. They take a very different model of advertising, however, in which broadcasters and advertisers bargain over their joint surplus (which leads to a result of minimal differentiation across the broadcasters) and they explore no policy instruments. While a number of economists have looked at radio broadcasting, informally discussing general issues (Coase (1966)) or formally modelling econometric analyses of specific aspects of the market (Berry and Waldfogel (1999a, 1999b), Anderson and Coate (2000) and Rogers and Woodbury (1996)), none address the issues we analyse here.

In the next section we set up our model before turning to an examination of some benchmark comparisons. Section IV then considers the laissez-faire market solution and Section V concludes.

## II. A MODEL

Suppose there are two types of content, Local and that of the Rest of the world. There are two radio stations and each makes a ‘locational’ choice in terms of the mix that it plays of these two kinds of content (for concreteness we shall henceforth talk only of music as the content). We shall denote a choice of only Local content as being at a location 0 on the interval  $[0,1]$ , *à la* Hotelling (1929), and a choice of only Rest of the world content as being at the other end of this interval at point 1. The two stations,  $L$

and  $R$ , are then described by their location along this interval and we also use the notation  $L$  and  $R$  to denote their locations where, without loss of generality,  $L \leq R$ . An important point to note is that we assume that the types of content are different in a horizontal rather than a vertical sense. Local music is not assessed by all listeners to be inferior to the international product, or superior, but, rather, it is a matter of taste.

## II.1. Demand

Consumers are distributed uniformly along this unit interval in terms of their preferences for mixes of the two kinds of music and have one unit of time to devote to listening to the radio. An insight of GLS is that this set-up mirrors the “combinable products” of Anderson and Neven (1989): each consumer located between the stations can “roll their own” optimal mix of the two kinds of content by taking an appropriate convex combination of the two stations. So if station  $L$  plays 80% local content and station  $R$  only 30%, for example, but consumer  $s$  prefers 50% local content, they can obtain that by listening to  $L$  40% of the time and  $R$  60% of the time.<sup>11</sup>

Every consumer gets utility of  $\underline{v}$  from listening only to their ideal mix of music and we suppose this is always sufficiently high that all consumers listen to the radio: the market is covered. As do GLS we assume that a consumer’s disutility from a less-than-ideal mix of content types is increasing and quadratic in the ‘distance’ from their ideal mix to the mix they consume. So a consumer located at point  $s$  consuming a

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<sup>11</sup> We assume that there are no switching costs involved in changing channels. Accordingly, a consumer located between two channels is truly indifferent to changes in their locations (so long as advertising remains the same). If there were costs to changing channels then a consumer might prefer fully polarised stations for reasons of convenience.

bundle  $\Gamma_s = \lambda L + (1-\lambda)R$  gets disutility associated with a less-than-ideal product mix of  $t(\Gamma_s - s)^2$  where  $t$  measures the utility cost of having a less-than-ideal mix.

Why would a consumer between  $L$  and  $R$  ever choose  $\Gamma_s \neq s$  i.e. a less-than-ideal product mix? While the radio stations are free to listeners, we suppose that consumers also get disutility from advertising interrupting their programming. If station  $j=L,R$  chooses to fill a fraction  $a_j$  of its broadcast time in advertising then the advertising disutility associated with bundle  $\Gamma_s$  is  $\tau[\lambda a_L + (1-\lambda)a_R]$  where  $\tau$ , subsequently set to unity, measures advertising disutility.<sup>12</sup> Thus a consumer at location  $s$  gets total utility of  $u(s, \lambda, L, R, a_L, a_R) = v - t[\lambda L + (1-\lambda)R - s]^2 - [\lambda a_L + (1-\lambda)a_R]$  and choosing  $\lambda$  to minimise this yields<sup>13</sup> the following *optimal*  $\lambda_s$ :

$$\lambda_s = \frac{2t(R-s)(R-L) + (a_R - a_L)}{2t(R-L)^2} = \frac{(R-s)}{(R-L)} + \frac{(a_R - a_L)}{2t(R-L)^2} \quad (1)$$

From this, note that

$$\Gamma_s = s - \frac{(a_R - a_L)}{2t(R-L)} \quad (2)$$

so that the optimal choice of content mix differs from the consumers' ideal mix only to the extent that advertising differs across the two stations. Also, from (1),

$$\begin{aligned} \lambda_s &\geq 1 \text{ as } s \leq L + \frac{(a_R - a_L)}{2t(R-L)} \equiv s_L \\ \lambda_s &\leq 0 \text{ as } s \geq R + \frac{(a_R - a_L)}{2t(R-L)} \equiv s_R \end{aligned} \quad (3)$$

<sup>12</sup> This disutility is linear in advertising and there is no difference between advertising heard at one station or the other. In this respect we have not only horizontal differentiation (in the location-specific disutility of a less-than-ideal music mix) but vertical differentiation in the non-location-specific advertising disutility.

<sup>13</sup> All omitted derivations are provided in a Technical Appendix available from the author.

where  $s_L$  and  $s_R$  are critical locations such that all consumers at  $s \leq s_L$  listen only to station  $L$  and all consumers with  $s \geq s_R$  listen only to  $R$ . So a consumer's mix of radio stations depends on her location in the following way:

$$s \in \begin{cases} s \leq s_L \\ [s_L, s_R] \\ s \geq s_R \end{cases} \Rightarrow \lambda_s = \begin{cases} 1 \\ \frac{(R-s)}{(R-L)} + \frac{(a_R - a_L)}{2t(R-L)^2} \\ 0 \end{cases} \quad (4)$$

where, to minimise notation, we let  $\lambda_s$  denote the optimal  $\lambda$  subject to the constraint  $\lambda \in [0, 1]$ . Note that the interval  $s_R - s_L = R - L$ .

We can now calculate the total audience,  $x_j$ , listening to each station  $j=L, R$ , given the locations and the amounts of advertising each chooses. Consider  $x_L$ . All consumers located with  $s \leq s_L$  consume only  $L$ ; no consumers with  $s \geq s_R$  consume any  $L$ ; and each consumer with  $s \in [s_L, s_R]$  spends a fraction  $\lambda_s$  of their radio time listening to station  $L$ . So:

$$x_L = \int_0^{s_L} f(s) ds + \int_{s_L}^{s_R} \lambda_s f(s) ds \quad (5)$$

But  $s$  is distributed uniformly on  $[0, 1]$ ,  $\lambda_s(s_L) = 1$  and  $\lambda_s(s_R) = 0$  so we get (6) (where  $x_R$  also follows from  $x_R = 1 - x_L$ ):

$$\begin{aligned} x_L(L, R, a_L, a_R) &= \frac{1}{2} \left[ \frac{(a_R - a_L)}{t(R-L)} + (R+L) \right] = s_L + \frac{1}{2}(R-L) \\ x_R(L, R, a_L, a_R) &= \frac{1}{2} \left[ 2 - (R+L) - \frac{(a_R - a_L)}{t(R-L)} \right] = 1 - s_R + \frac{1}{2}(R-L) \end{aligned} \quad (6)$$



## II.2. Advertising

The role of advertising in the broadcasting literature is a controversial one.<sup>14</sup> At one extreme it might be seen as purely a nuisance on aggregate: while it determines which products consumers favour, it has no effect on overall expenditure and advertising costs are a deadweight social loss resulting from a Prisoners' Dilemma amongst competing advertisers. At the other extreme it is socially useful in that it provides information to otherwise ignorant consumers.

As in all models of broadcasting, the exact welfare results of our analysis will be sensitive to the view taken on the rationale for advertising. The model we use here represents a reduced form of a model developed by Anderson and Coate (2000). They consider broadcasters airing one of two programmes and consumers with a preference for one of two programmes. In their model, a continuum of producers indexed by  $\sigma \in [0, \underline{\sigma}]$  (where  $\underline{\sigma} < 1$ ) sell new goods which must be advertised to make consumers aware of them. When a consumer sees an advertisement for a particular product they are willing, with probability  $\sigma$ , to pay their reservation price  $\omega$  for it and, with probability  $1 - \sigma$ , to pay 0; this compares to paying 0 with probability 1 if they do not see the advertisement. So producers all rationally set a price of  $\omega$  and, while advertising is socially useful (advertisers sell nothing in its absence but get positive expected surplus from it) it nevertheless yields no informational benefit to consumers. Anderson and Coate (2000) demonstrate that this model of advertising, embedded in a particular model of commercial broadcasting, results in a demand curve for advertising at a station that is decreasing in the price of advertising and increasing in the station's market share.

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<sup>14</sup> See Anderson and Coate (2000) footnote 3 for a more complete discussion of alternative views of the role of advertising in economic models.

We think that these comparative statics – that the demand for advertising at a radio station decreases as its price rises but increases as the station's audience increases – seem very compelling in the context of free-to-air broadcasting. Other features of the Anderson and Coate model, however, do not; in particular their result that demand for advertising at one station is independent of whether or not the producer has advertised at the other station. Similarly, the GLS vertical differentiation model of advertising results in demands for advertising at each station that do *not* depend at all on the rival's advertising price.

So our approach is simply to capture these desirable comparative statics effects in the simplest possible formulation of the advertisers' problem. We suppose that each radio station simply faces a competitive demand for advertising time from advertisers who seek to maximise some monotonic increasing function  $f(a_j x_j)$ ,  $j=L,R$ , of total advertising exposure: the number of consumer-minutes advertised. This affects advertisers' sales of output, which has price  $\underline{p}$ . So, as in Anderson and Coate (2000), advertising is potentially socially useful here<sup>15</sup> although it yields no net gain to consumers. Each advertising minute costs  $p_j$  so, given this price, advertisers solve the following programme:

$$\underset{\{a_j\}}{\text{Max}} \quad \underline{p}f(a_j x_j) - p_j a_j \Rightarrow p_j = \underline{p}f' \frac{d(a_j x_j)}{da_j} \quad (7)$$

It is noteworthy that, in our specification, advertisers at one station do not advertise at the other. Nevertheless, we show below that they are affected by prices at the other station (as these affect advertising there and so the efficacy of their own advertising in terms of market share.) The main rationale for this assumption is that it

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<sup>15</sup> Potentially only, because the gain to advertisers must be set off against the nuisance cost of advertising to consumers.

mirrors the reality of radio advertising where advertisers are very genre- and therefore station-specific and it can be formalised in a very simple way.<sup>16,17</sup> Suppose that the likelihood of a consumer responding to an advert for a particular product correlates with their preferences over music content. That is, exposure to adverts for  $L$ -type ( $R$ -type) products is more effective in persuading a consumer to buy those products the stronger is the consumer's preference for  $L$ -type ( $R$ -type) programming. For example, a heavy metal enthusiast may be more (less) likely than a fan of easy listening music to respond to an advertisement for ear studs (golf clubs). If there is some fixed cost to advertisers in constructing an advertising campaign at a station then, even if the degree of consumer susceptibility to adverts for different types of product varies continuously with preference for music type (i.e. location), an advertiser may choose to run a campaign at only one station. The chosen station will be the one at which advertising for that product is more effective in terms of appealing to consumer types. As noted, casual empiricism supports the notion that radio advertisers target specific stations and do not tend to diversify their campaigns.<sup>18, 19</sup>

### II.3. Welfare

Total welfare,  $W$ , is total consumer welfare,  $U$ , plus radio stations' profits, plus total surplus accruing to advertisers at each station,  $S_L$  and  $S_R$  respectively, where  $S_j = f(a_j x_j) - p_j a_j$ . Starting with consumers, for a consumer at  $s \leq s_L$  disutility is  $t(L-s)^2 + a_L$  while for

<sup>16</sup> I thank the Editor for suggesting more detailed discussion of this aspect of the model.

<sup>17</sup> Available in the Technical Appendix.

<sup>18</sup> This seems less true of television advertising, at least in the context of network broadcasters, but this is consistent with the model outlined above: TV networks tend to be more homogeneous in their programming (compared to niche radio broadcasters) but it is the relative specialisation of content that attracts advertisers in our story.

<sup>19</sup> Note that we do not carry this formal model through the rest of the paper as it would complicate matters excessively. In particular, policy interventions that lead the radio stations to become more similar, while not reducing the incentive to advertise at only one station, would lessen the attraction of advertising at any particular station.

$s \geq s_R$  disutility is  $t(s-R)^2 + a_R$ . For a consumer at  $s \in [L, R]$  disutility is  $t(\Gamma_s - s)^2 + \{\lambda_s a_L + (1 - \lambda_s) a_R\}$ . Hence,

$$U = \int_0^{s_L} [\underline{v} - a_L - t(L-s)^2] ds + \int_{s_L}^{s_R} [\underline{v} - \{\lambda_s a_L + (1 - \lambda_s) a_R\} - t(\Gamma_s - s)^2] ds + \int_{s_R}^1 [\underline{v} - a_R - t(s-R)^2] ds \quad (8)$$

Let  $A$  denote total advertising heard i.e.

$$A \equiv a_L x_L + a_R x_R \quad (9)$$

Then, substituting in for the optimal  $\lambda_s$ , we can rewrite utility:

$$U = \underline{v} - A - \frac{t}{3} [L^3 + (1-R)^3] - \frac{4t}{81} (R-L)(1-(R+L))^2 \quad (10)$$

Now, defining  $Y$  as (broadly) producers' surplus,

$$Y \equiv \pi_L + \pi_R + S_L + S_R = (p_L a_L - F) + (p_R a_R - F) + (f(a_L x_L) - p_L a_L) + (f(a_R x_R) - p_R a_R) = f(a_L x_L) + f(a_R x_R) - 2F$$

where each radio station incurs a fixed operating cost of  $F$ . Thus,

$$W = \underline{v} - 2F - \frac{t}{3} [L^3 + (1-R)^3] - \frac{4t}{81} (R-L)(1-(R+L))^2 + \sum_{j=L,R} [a_j x_j - f(a_j x_j)] \quad (11)$$

#### II.4. A restriction

We assume henceforth a particular form of the  $f(\cdot)$  function such that  $f'(\cdot) = 1$  and we normalise  $\underline{p}$  to unity. As a consequence we can simplify total producers' surplus as  $Y = A - 2F$  and thus welfare becomes:

$$W = \underline{v} - 2F - \frac{t}{3} [L^3 + (1-R)^3] - \frac{4t}{81} (R-L)(1-(R+L))^2 \quad (12)$$

This restriction warrants further comment. Note that while the normalisation of  $\underline{p}$  to unity is innocuous, our assumption that the marginal product for advertisers, in

terms of goods sales, of another unit of audience is always unity is not innocent. Indeed, it is the source of our result that advertising has no welfare effects in this model, the reason being that it means another minute of advertising in aggregate always increases the surplus to advertisers (the price of advertising being just a transfer between advertisers and the radio stations) by exactly the same amount as it decreases the utility of listeners, which is linear in the total amount of advertising. As a consequence advertising here serves a role isomorphic to that of prices in the more usual Hotelling model: it is purely a transfer between consumers and firms.

The rationale for this assumption is tractability: it is this property that enables the model to be solved in closed-form. Nevertheless, it should be recognised that it does determine the specific nature of our welfare results; we provide some conjecture on their robustness in the absence of this restriction in the paper's conclusion.

Given this restriction, from (6) we can solve the first-order conditions in (7):

$$\begin{aligned} a_L(L, R, p_L, p_R) &= \frac{1}{3}t(R-L)[2 + (R+L) - 2(2p_L + p_R)] \\ a_R(L, R, p_L, p_R) &= \frac{1}{3}t(R-L)[4 - (R+L) - 2(2p_R + p_L)] \end{aligned} \quad (13)$$

Note that advertising with station  $j=L, R$  decreases both with its own price and the price of advertising at the other station: advertising prices are strategic substitutes for the radio stations (in contrast to both the Anderson and Coate (2000) and GLS models, as noted earlier.) The reason for this is that an increased price at one station discourages advertising thus increasing consumer demand and so making advertising at the rival station less attractive to advertisers.

### III. SOME BENCHMARKS

#### III.1. The subscription case

First, to isolate the role played in our subsequent analysis by our advertising model, suppose the radio stations were funded purely by subscription.<sup>20</sup> While this is currently more of a reality for television than radio, nevertheless it provides a useful benchmark. We consider two versions of a subscription channel. One involves solely a fixed fee for subscription, independent of the amount of listening/viewing undertaken. The other involves a price charged directly to consumers per-minute of broadcasting time consumed (pay-per-view in the context of television.)

In the first of these, suppose a consumer must pay a fixed fee,  $P_j$ ,  $j=L,R$  to a station in order to receive its programming. Assuming the market is covered (i.e. all consumers receive at least one station), we may again have three types of consumer: those who listen to only one station and those that listen to both. For the latter, utility is given by  $u(s, \lambda, L, R, a_L, a_R) = \underline{v} - t[\lambda L + (1-\lambda)R - s]^2 - (P_L + P_R)$  and there is now no reason to ever choose an optimal mix that differs from  $s$ : the optimal  $\lambda$  is just  $\lambda = \frac{R-s}{R-L}$  yielding utility of  $\underline{v} - (P_L + P_R)$ . This compares to  $\underline{v} - t(s-L)^2 - P_L$  when consuming only L and  $\underline{v} - t(R-s)^2 - P_R$  when consuming only R so we can again categorise consumers by their location and listening pattern:

$$\left. \begin{array}{l} \text{only to L} \\ \text{Listen to both} \\ \text{only to R} \end{array} \right\} \text{ as } \begin{cases} s < s_L \equiv L + (\sqrt{P_R}/t) \\ s \in (s_L, s_R) \\ s > s_R \equiv R - (\sqrt{P_L}/t) \end{cases}$$

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<sup>20</sup> I am grateful to a referee for suggesting this exercise.

Suppose there exists a range of consumers subscribing to both stations. Then the total number of listeners at each station is  $x_L = s_R$  and  $x_R = I - s_L$  and profits of the two stations are simply  $\pi_L = P_L x_L = P_L s_R$  and  $\pi_R = P_R x_R = P_R (I - s_L)$ . Maximising these over the relevant price yields optimal prices in the final stage of the stations' location and pricing game and evaluating  $s_j$  at these prices yields  $s_L^* = \frac{1}{3}(2 - L)$  and  $s_R^* = \frac{1}{3}R$ . However, for some consumers to subscribe to both requires that  $s_L^* < s_R^*$  or  $R + L > 2$  which is inconsistent with given  $L \leq R \leq I$ . That is, regardless of locations, it is always optimal for the stations to raise prices until consumers choose to subscribe only to one station.

As a consequence, our results for this case are exactly the same as those for a standard Hotelling model with non-combinable products. There is a marginal consumer at location  $x$  defined by  $t(x - L)^2 + P_L = t(R - x)^2 + P_R$  and we can solve for optimal prices which then yield the following profit functions for the firms:

$$\begin{aligned}\pi_L(L, R, P_L, P_R) &= \frac{1}{18} t(R - L) [2 + (R + L)]^2 \\ \pi_R(L, R, P_L, P_R) &= \frac{1}{18} t(R - L) [4 - (R + L)]^2\end{aligned}\quad (*)$$

Choosing locations to maximise profits then yields maximal differentiation:  $L = 0$  and  $R = I$ . In this setting, however, maximal differentiation of the stations is not socially optimal (for the same reason that it is not socially optimal in a standard Hotelling model.) The subscription fees are simply a transfer and social welfare is simply consumer utility less the stations' fixed costs. The socially optimal locations are then those that minimise aggregate transport costs:  $L = 1/4$  and  $R = 3/4$ .

An alternative form of subscription station is one in which the stations charge by the extent of a listener's usage – the analogue of pay-per-view television. In this set-up the prices charged by the stations serve exactly the role played by advertising levels in our model. Consequently, consumer demands here are exact analogues of

those in section II.1 but with prices replacing advertising levels:  $p_j$  instead of  $a_j$ . Station  $j=L,R$  then chooses  $p_j$  to maximise  $\pi_j=p_jx_j-F$  which yields price reaction functions and these can be solved for equilibrium prices in terms of locations alone yielding, in turn, market shares and profits, all as functions of locations. Choosing locations simultaneously to maximise these profit functions yields the principle of maximal differentiation: the radio stations choose locations  $L=0$  and  $R=1$ . Again this is not socially optimal for the same reasons as in the previous subscription model.

### III.2. The first-best solution

Second, returning to the model laid out in Section II, suppose a benevolent social planner could choose all quantities and locations.<sup>21</sup> As noted, the level of advertising is irrelevant to social welfare – it washes out of (12) as it is purely a transfer from consumers to radio stations and advertisers. This also implies that even if the planner could *only* choose locations the first-best could still be attained. The first-best choice of locations, then, seeks solely to minimise the disutility to consumers of getting a less than ideal music mix and involves maximal differentiation –  $L=0$  and  $R=1$  – and yields  $W=\underline{y}-2F$ . Maximal differentiation means every consumer can construct his or her own ideal mix of content so there are no disutility costs at all. What sort of music is played in equilibrium? Clearly a half of all music *played* is local and a half is from the rest of the world. This is also true of the music *heard*, which we denote  $M_L$ : all

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<sup>21</sup> One might also consider a second-best solution in which the planner is subject to a non-negative profit constraint on the radio stations. We ignore this constraint throughout (because it is effectively a condition on  $F$  that is uninteresting unless one is concerned with the pattern of entry, not the focus of this paper – implicitly we assume that any losses are covered by the regulator) so the second-best solution is of little interest here.



listeners get a mix of  $L$  and  $R$  for, on average, 50% local content. So in the first-best we get  $M_L = 1/2$ . We summarise this all in Proposition One.

**Proposition One:** *Absent any externality attached to local music, first best locations involve maximal differentiation:  $L=0$  and  $R=1$ , whether or not advertising levels can also be chosen: the level of advertising is irrelevant to welfare in the first best. Half of all music heard in equilibrium is of local origin.*

#### IV. THE LAISSEZ-FAIRE SOLUTION

In contrast to the previous section, suppose the planner delegates all choices of locations and advertising prices to the radio stations i.e. we look for the laissez-faire market solution.

##### IV.1. The stations' problem

We seek a subgame perfect equilibrium to a 2-stage game in which radio stations first simultaneously choose their locations and then simultaneously set advertising prices, given the advertising demand of advertisers, as already discussed.

In the second stage, each station chooses the price to charge for advertising, knowing the advertisers' consequent demands as given in (13). For station  $L$ , for example, the problem is to choose  $p_L$  to maximise  $\pi_L = a_L p_L$  given locations and given (13). That is,

$$\begin{aligned} \max_{\{p_L\}} \pi_L &= a_L p_L - F = \frac{1}{3}t(R-L)[(2+R+L-2p_R)p_L - 4p_L^2] - F \\ \Rightarrow p_L &= \frac{1}{8}(2+(R+L)-2p_R) \end{aligned} \quad (14)$$

Similarly,  $R$  chooses  $p_R$  to maximise  $\pi_R = a_R p_R$  given locations and (13), which yields:

$$p_R = \frac{1}{8}(4 - (R + L) - 2p_L) \quad (15)$$

Solving the reaction functions (14) and (15) yields equilibrium prices and these in turn yield equilibrium advertising levels as functions of locations only. We can then use these to get profits as functions of locations only. To summarise:

$$\begin{aligned} p_L(L, R) &= \frac{1}{30}(4 + 5(R + L)) & p_R(L, R) &= \frac{1}{30}(14 - 5(R + L)) \\ a_L(L, R) &= \frac{t(R - L)}{45}(8 + 10(R + L)) & a_R(L, R) &= \frac{t(R - L)}{45}(28 - 10(R + L)) \\ \pi_L(L, R) &= \frac{t(R - L)}{(45)(15)}(4 + 5(R + L))^2 - F & \pi_R(L, R) &= \frac{t(R - L)}{(45)(15)}(14 - 5(R + L))^2 - F \end{aligned} \quad (16)$$

In the first stage of the game, then, the stations choose these locations simultaneously knowing the subsequent prices and advertising levels that will result. Solving for the equilibrium locations yields closed-form expressions for equilibrium prices, advertising levels and profits, denoting laissez-faire values with asterisks:

$$\begin{aligned} L^* &= 0.05 & R^* &= 0.95 \\ p_L^* &= p_R^* = \frac{3}{10} & a_L^* &= a_R^* = \frac{9}{25}t \\ \pi_L^* &= \pi_R^* = \frac{27}{250}t - F & x_L^* &= x_R^* = \frac{1}{2} \end{aligned} \quad (17)$$

Note that, in contrast to both GLS who demonstrate maximal differentiation and Gal-Or and Dukes (2002) who obtain minimal differentiation, we get incomplete differentiation. As with similar models (see d'Aspremont *et al* (1979)) there is an incentive here for the forward-looking stations to locate away from each other in order to lessen subsequent competition which shows up here in advertising levels: these serve the role of prices to consumers. The difference between this model and a standard Hotelling model, however, is in the relationship between market share and profits. In the usual Hotelling setting an increase in market share, at given prices, feeds directly into higher profits as the firm's maximand is the product of price and

market share. In our model, however, the effect on profit of market share is mediated through the price of advertising: given the level of advertising, an increased market share enables the firm to charge more for its advertising time. So whereas a Hotelling firm in the direct analogue of this model would choose location to maximise  $a_j x_j$  directly (as  $a_j$  serves the role of prices), our firm seeks to maximise  $a_j p_j$  where the first-order condition for advertisers implies that  $p_j = d(a_j x_j) / da_j$ . As a consequence the losses to a firm from moving away from its rival in this model are greater than those from the same exercise in the more usual Hotelling setup and we get less than complete differentiation. This does not stem from the combinable products aspect of the model (as it does not hold in the subscription version of the model, as noted) but, rather, from our modelling of advertising.

Intuitively, both the radio stations' profits and advertising are increasing in  $t$ , consumers' disutility cost: as consuming a less-than-ideal mix becomes more costly each station has more market power. This translates into more advertising at a given price as the consequent marginal loss of market share is less significant the higher is  $t$ .

What sort of music is played in equilibrium? Again a half of all music *played* is local and a half is from the rest of the world. This is also true of the music *heard*: 5% of listeners listen only to station  $L$  and get 95% local content, 5% listen only to station  $R$  and get only 5% local content, and the remainder get a mix of  $L$  and  $R$  for, on average, 50% local content. So in the no-intervention case we again get, as in any symmetric outcome,  $M_L = 1/2$ .

## IV.2. Welfare

In the laissez-faire solution, from (16), we can evaluate consumers' utility and social

welfare directly as  $U^* = \underline{v} - \frac{4,321t}{12,000}$  and  $W^* = \underline{v} - \frac{t}{12,000} - 2F$  respectively.

Diagrammatically we can portray utility as in Figure 1. All consumers suffer some disutility from advertising (equal at both stations). Welfare is highest for consumers between  $s_L$  and  $s_R$  who mix both stations to get their ideal personal mixes. Consumers closer to 0 (respectively 1) than  $L$  ( $R$ ) listen only to  $L$  ( $R$ ) but incur increasing (quadratic) disutility costs the more (less) local content they prefer.

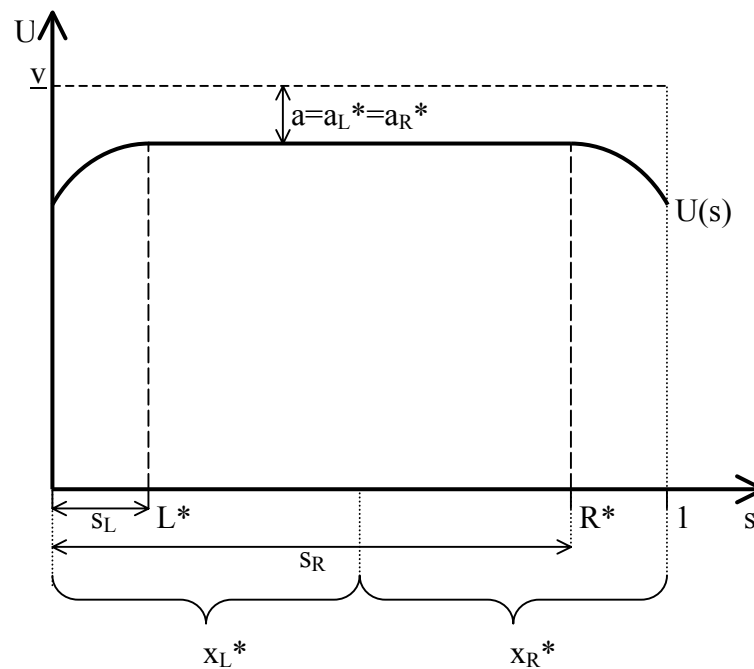


Figure 1

It is straightforward to show that the *optimal* symmetric locations are  $L=0$  and  $R=1$ . If the planner were to impose this maximal differentiation but let the stations determine the advertising equilibrium, we would get higher profits for the stations and greater surplus for advertisers than in the laissez-faire solution. But total consumer welfare is actually lower: even though this would yield  $U=v-a$  (so the only disutility is from advertising) we would have greater advertising in equilibrium than in the laissez-faire solution. Indeed, *consumer* utility is maximised at  $L=R=0.5$  when market equilibrium advertising is considered – *less* differentiation than in the laissez

faire solution. Interestingly, if the radio stations were to collude on their locations we would also get maximal differentiation: the socially optimal solution.

In contrast to the standard Hotelling model in which the laissez-faire solution gives more differentiation than is socially optimal, in our model we get less. This is both because our social optimum is more differentiated than in Hotelling and because our laissez-faire outcome is less differentiated. The former is due to the combinable goods: in a standard Hotelling model prices are a pure transfer and optimal locations are simply those that minimise total transport costs whereas with combinable products transport costs play less of a role in determining the social optimum. The latter effect is because, as discussed, the incentive to move apart is lessened by the way in which market share feeds, through the demand for advertising, into the stations' profits.

We summarise this discussion in Proposition Two.

***Proposition Two:*** *The laissez-faire non-cooperative solution involves less than maximal differentiation. Compared to the outcome under maximal differentiation but with endogenous advertising – also the outcome if firms were to collude on location choices – the laissez-faire solution yields lower advertising, higher consumer surplus and lower profits to both radio stations and advertisers. Again, half of all music heard is local.*

## V. CONCLUSION

This paper has developed a model in which radio stations choose a mix of local and international content to play to consumers with diverse preferences, driven by the ability to sell advertising to advertisers seeking maximum market coverage. In this setting we have shown that laissez-faire locations involve less than (socially optimal) maximal differentiation by the radio stations.

Our exact results are, of course, special to the exact assumptions we have made, but we argue in Richardson (2004) that the overall thrust of them seems more general. In particular, the general tenor of our comparative statics results also seems quite robust as they stem from the model's Hotelling construction rather than the advertising model we use. Our welfare conclusions, however, are likely to be more fragile. We have maintained a restriction on the advertising side of the model resulting in the level of advertising having no effects on aggregate welfare, the gains to advertisers exactly offsetting the losses to consumers. This is clearly significant in determining the attractiveness or otherwise of policy interventions.

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